# What's revolutionary about the Chemical Revolution?[1]

or, How an event in chemistry shaped philosophy

In the 1770s Antoine Lavoisier proposed a theory that would result to such an extraordinary change in chemistry, that it would later be referred to as the Chemical Revolution. His oxygen theory of combustion did not only bring forward the discovery of a new element, namely oxygen. It also signified the end of what was previously regarded as the standard understanding of combustion and of chemical phenomena more broadly; namely the end of phlogiston theories and the subsequent rejection of the element phlogiston.

The effects this historical event has had to the development and success of chemistry is not hard to appreciate. What is perhaps not so evident is how important this event has been to the development of philosophical ideas. Here I sketch the philosophical issues that have been mostly influenced by the study of the Chemical Revolution.

The first thing that most probably comes to the mind of a philosopher when hearing about the Chemical Revolution, is the notion of 'scientific revolutions'. In large part, this is because the Chemical Revolution has been studied in one of the most influential and popular philosophical books of the past century; namely Thomas Kuhn's *The Structure of Scientific Revolutions*.[i] In this book, Kuhn proposes a quite insightful and (at the time of its publication) very novel account of how science undergoes changes and alters its understanding of the world.

Kuhn popularised the terms 'incommensurability', 'normal science', 'scientific revolution', and perhaps the most famous one of all, 'paradigm shift'. According to his account, prior to Lavoisier's oxygen theory, there was a period of 'normal science' during which chemists took phlogiston theories to form part of their 'world view'. At that time, chemists would be occupied with merely determining unspecified chemical facts and clearly articulating their theory (Kuhn calls this activity 'puzzle solving'). However when 'anomalies' occurred, namely instances in which experimental results didn't match with what was expected by phlogiston theories, chemistry underwent a 'crisis'. This crisis involved a debate among different candidate theories that would accommodate the anomalies, and a subsequent debate on chemists' world views.

What is perhaps most important in Kuhn's proposal is that it claims that science progresses in a substantially discontinuous manner. The shift from phlogiston theories to the oxygen theory involved a change in not only chemists' world views, but in the language and concepts, questions, projects and research goals they pursued after the acceptance of Lavoisier's proposal. These changes

[1] Final version of this article can be found here: https://www.chemistryworld.com/opinion/whats-revolutionary-about-the-chemical-revolution/4013835.article

were so significant, that a comparison between past and present chemical theory is impossible- hence the so-called 'incommensurability'!

This is what constitutes the occurrence of a paradigm shift and what Kuhn claims happened with the Chemical Revolution. Of course there are many more interesting features to Kuhn's account and - as often happens in philosophy- there is a lot of subsequent work that questions whether Kuhn is right about how the Chemical Revolution unfolded.[ii] In any case, Kuhn's work has been extremely influential to philosophical thought and the study of the Chemical Revolution plays a very important role in evaluating not only his work but in general how science evolves.

**Realism, progress and the structure of scientific theories**

However, philosophical questions are interconnected and answers that are given for one topic often prompt questions regarding a different one. This is the case with the Chemical Revolution as well. Its impact on philosophy's understanding of theory change resulted in further questions about (among other things) the reality of chemical entities, scientific progress, and the structure of scientific theories.

For example, the Chemical Revolution exemplified a major philosophical worry about scientific realism. How was it possible that during the reign of phlogiston theories, chemists managed to make good use of chemistry and even produce (at least to an extent) accurate empirical results? Given that- as is turns out- phlogiston does not exist, this is quite worrying![iii] It suggests that even with our best current theories, empirical success is not a guarantee that the scientific entities we posit actually exist. (see the pessimistic induction argument in my previous article)

In conclusion, the Chemical Revolution is a very important case study in the investigation of various philosophical questions. Its role in the history of science is quite unique and stands out relevant to other episodes in science. This is ultimately why historians and philosophers of science are still so interested in this event, even though it's been quite a long time since chemists entertained the idea that phlogiston is what makes things burn!

[i] Kuhn, T.S., 2012. *The structure of scientific revolutions*. University of Chicago press.

[ii] For example see Blumenthal, Geoffrey (2013). Kuhn and the Chemical Revolution: a re-assessment. *Foundations of Chemistry* 15 (1):93-101.

[iii] An intriguing philosophical account that argues in favour of the existence of phlogiston can be found here: Chang, H., 2016. Scientific realism and chemistry. In *Essays in the philosophy of chemistry*. Oxford University Press.